contains narratives by actual travellers, such as those edited by Mr. Wherry (3); these can be used as school readers, or can be set for home reading; this particular set deals with early climbs in the Alps. The second kind takes the form of a special study of a limited area, and the volume on "Cheshire" (4) illustrates the way in which the pupil may be brought into touch with the work of a specialist; such books should be in the geographical reference library. These works appear to typify the best efforts of modern teachers of geography.

B. C. W.

ELECTRICAL ENGINEERING.

(1) *Electrotechnics.* By Dr. John Henderson. Pp. xiv+165. (London: Longmans, Green and Co., 1909.) Price 3*s.* 6*d.*

(2) *Practical Testing of Electrical Machines.* By L. Oulton and N. J. Wilson. Pp. vi+210. (London: Whittaker and Co., 1909.) Price 4*s.* 6*d.* net.

1) THE efficient organisation of students' work in an electrical engineering laboratory is a difficult task, and especially so with large elementary classes. Advanced students may be trusted with delicate instruments and left to arrange the necessary connections by themselves, they require little supervision, and as their number is small this is easily given. With elementary classes the case is different. It is obviously impossible to let all the men do the same tests simultaneously, since that would require multiplication of apparatus beyond the financial capacity of most institutions. Hence tests of different kinds must go on at the same time, and since the demonstrator cannot personally supervise every one of these different tests from its beginning, it is important that the students should get very clear instructions in print. It is also important so to arrange the tests that they shall, with students of average ability, take about the same time, and to arrange the work generally with the precision of a railway time-table, because otherwise students will drop out of their order and fail to get the full benefit of the course. All this, and the necessity to adapt the work to the class of students attending and to the equipment which happens to be available in any particular institution, tends to make the instruction somewhat cut and dried in character, and this is likely to detract from its educational value.

The author, who has evidently experience of these difficulties and the way to make the best compromise possible between conflicting requirements, has, in the third volume of this series of physical and electrical engineering laboratory manuals, given us an excellent guide to laboratory work of this kind. He does not believe in the use of special apparatus, but very rightly teaches his students to make the tests in the laboratory very much in the same way that they will have to adopt when they get into practical life, that is, by the use of ordinary commercial instruments. He also adopts the principle that tests must be so arranged that only two, or at the outside three, men are necessary for any one test.

The subject-matter is divided into three parts, which roughly correspond to the City and Guilds of London syllabus for the "elementary stage" and the "ordinary grades" of direct and alternating current engineering. We thus get in the first part Ohm's law, the Wheatstone bridge, calibration of instruments, fuse testing, some simple magnetic tests, and experiments with a small motor. In the second part we come to heating of wires, potentiometric measurements, more advanced magnetic testing, characteristics of dynamos, secondary batteries, photometry, losses in dynamos, and so on. The third part deals mainly with the fundamental relations of alternating currents, graphic methods of representing these, and some very simple tests on alternators. Transformers and motors are not dealt with.

In an appendix are given mathematical and physical tables which will be found very useful, not only by the student, but also by the practical engineer. So far as the student is concerned, some of these tables should bring home to him a sense of reality of his work. Students are apt to consider their class-work as something purely scholastic and detached from practical life. If, then, a student, after having in his work found some physical fact such as the fusing current of a certain wire, the E.M.F. of a given cell, or the power per candle required by, say, an Osram lamp, and then turns to the tables at the end of this book to see how his determination agrees with the figures there given, he must get the impression that what he has done in the laboratory has practical importance, and this conviction will give him additional interest and pleasure in his work.

(2) This book is intended as a guide in testing electrical generators and motors. In the preface the authors point out that it is impossible to give "all the theory that the subject entails," and that the reader must therefore also consult some of the many textbooks. This is obviously right; nobody can expect to find in a book which is primarily an instruction how to test the whole of the theory of electrical machines, but some fundamental theories must be given, and in this respect the book falls short of what the reader has a right to expect. The authors give some sort of theory, but it is neither closely reasoned nor always clearly expressed. The latter defect may to some extent be due to their adoption of some terms which give one the impression of being a kind of technical jargon employed in a particular shop or laboratory, though not generally found in scientific books. For instance, if we are told to take a "locked saturation" it is not immediately obvious that we have to determine the relation between starting torque and voltage of an induction motor; nor is it very clear what a "pressed down reading on the scales with the power off" might mean. On p. 34 we read that "C.B. is the leakage current and proportional to the current in the motor." Further that it is "required to overcome the counter E.M.F. due to leakage."

These are of course merely unfortunate ways of expressing certain ideas which the authors have correctly in their minds, but it is irksome for the reader to have continuously to exercise his ingenuity in order to find out what it is the authors really mean. In some cases this task looks almost hopeless, as, for

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instance, when on p. 7 we find that for a star-connected motor the "total current" is $\sqrt{3}$ times the current per phase, and on p. 8 we read that the "total current" is $\sqrt{3}$ times the "current per terminal." What the authors may mean by their term "total current" is not otherwise explained, and the reader can only surmise that it is merely a conventional way of introducing a current which is proportional to the line current. The introduction of such a conventional term is, however, quite unnecessary, as is also the introduction of the term "apparent efficiency" (p. 30), which has no physical meaning, since it is the ratio of voltamperes, which is not power, to watts, which is power. The authors also distinguish between "real horse-power" and "brake horse-power," and thus give the reader the idea that brake-power is not real power, whereas they merely mean to distinguish between the electrical power input and the mechanical power output of a motor. This is quite clear from the text, but why puzzle the reader by using new or misapplying old terms?

The efficiency tests described are all direct, that is to say, input and output are measured and their ratio calculated; the authors think this less inconvenient than some method of determining efficiency by the measurement of lost power, or, as they call it, the "loading back" method. This may be true so long as one has to deal with very small machines, but most practical engineers prefer to test large machines by some differential method. One counsel given by the authors should be followed in testing every kind of machine, namely, to plot results as the test proceeds, so that doubtful observations may be eliminated before the test is finished and the apparatus dismantled. The tests described comprise a 50-horse-power induction motor, a 500-kilowatt generator, a 300-kilowatt rotary converter, a 75-horse-power single-phase railway motor, a 450-kilowatt direct-current generator, a 40-horse-power direct-current motor, and an enclosed railway type of motor of only 12 horse-power. These tests are explained very fully, and the results are given in tables and curves, which are carefully compiled. The reader having once accustomed himself to the authors' peculiar nomenclature (such as "rack" for rheostat, and the terms alluded to in the first part of this review) will find no difficulty in following the sense of the text, and will derive some benefit from the book by following the examples given if he has to make similar tests.

GISBERT KAPP.

THE PHYSIOLOGICAL ANATOMY OF PLANTS.

Physiologische Pflanzenanatomie. By Prof. G. Haberlandt. Vierte neuarbeitete und vermehrte Auflage. Pp. xviii+650. (Leipzig: W. Engelmann, 1909.) Price 19 marks.

THE first edition of Prof. Haberlandt's well-known work appeared in 1884, so that (as the author points out) it has already reached a respectable antiquity, as the age of scientific text-books is reckoned. But, even before 1884, Haberlandt was beginning to be known for researches of a kindred sort, *e.g.* in the protective adaptations in seedlings (1877), and on the relation between structure and function illustrated by the assimilatory tissues (1880). By persistent work in this general direction he has made himself the recognised authority on "physiologische Pflanzenanatomie." Haberlandt dedicated his first edition "mit dem Ausdruck freundschaftlicher Verehrung" to Prof. Schwendener.[1] This was appropriate, because it was Schwendener, in his celebrated work, "Das mechanische Prinzip, &c.," who "raised anatomico-physiological research above the level of casual tentative experiment, and marked it out, once for all, as a definite department of science."[2]

Structure in relation to function is an old subject of inquiry, but it was pursued on theological rather than on scientific lines before the publication of the "Origin of Species," and Haberlandt's work is the direct outcome of that book. At first, however, adaptation was principally studied in the external characters serving for fertilisation, dispersal of seeds, &c. The meaning of histological peculiarities was neglected, or strangely perverted, as, for instance, in the comparatively recent dogmas that vessels do not serve as water-pipes, or stomata for gaseous exchange. Schwendener's work showed, in the most unexpected and brilliant way, the value to the plant of such a neglected point as the sectional outline of its mechanical tissues. After this the study of adaptation could not be confined to obvious macroscopic points, and Schwendener's work led up to the classification of tissues according to their physiological character, which forms the basis of Haberlandt's book.

Since the first edition (1884), Haberlandt's book has flourished and increased, as may be shown by the simple process of counting the pages. Edition i. contained 398 pp.; edition iv. 650 pp. Edition i. had 139 figures in the text, and these have increased to 291. This represents the legitimate growth of the subject, and it is to be noted that Haberlandt, from the extent of his own work, is well fitted to make use of the researches of others. Huxley has well said that only a man who knows the raw material of science at first hand can judge of the amount of "speculative strain" that the elements of a given problem will bear. It is this sort of knowledge that makes Haberlandt an admirable critic and exponent of the work of others.

If we compare the present volume with the first edition, the most striking point in which the modern book differs from its ancestor is the presence of a chapter on sense-organs." Botanists will be glad to have, in a compass of 50 pp. or so, a full discussion of the scattered controversies on this subject. Haberlandt's statolith theory of the sense-organs for the perception of gravity, and of the lens-function of the epidermis in relation to heliotropism, are the most speculative of his views, and are by no means universally accepted, but the most sceptical can hardly refuse to admire the skill with which these exciting hypotheses are upheld.

F. D.

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[1] The present dedication bears the additional words "on the completion of his 80th birthday."

[2] Haberlandt's preface to his first edition, p. viii.

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